Rapid Ecological Assessment of Forests and Associated Exotic Earthworms in the Laurentian Mixed Forest-Great Lakes Coastal Biological Network, Midwest Region, National Wildlife Refuge System, US Fish & Wildlife Service[1]

FOREST COMMUNITY ANALYSIS: Ottawa NWR

Differences in Overstory Composition Among Stands. Using relative basal area (%) by species of the 54 plots sampled across 10 stands at Ottawa NWR as part of the Rapid Ecological Assessment (Corace et al. 2011), we used a Multi-Response Permutation Procedure (MRPP) to examine if there are differences in the *overall overstory composition* among the 10 stands. MRPP is a non-parametric technique that tests the hypothesis that there is no difference between groups of entities, in this case the overstory composition of stands at Ottawa NWR.

We conducted a MRPP using Sorenson's distance and PC-ORD (ver. 5.0) software. Overall, there is a statistically significant difference in the overstory composition among the stands (T = -10.387; A = 0.224; $P < 0.001$). The results of the MRPP support the data as described in the SUMMARY TABLES & FIGURES document for the Ottawa NWR that suggest differences in the overstory composition (Corace et al 2011). We also calculated post-hoc pairwise comparisons between stands and found the following statistically significant differences:

Stand	Significantly Different in Terms of Overstory Composition with:
Butternut	Crane Creek*; Darby Beach*; Darby West**; CedarPoint Lambswoods*;VCW*
Boss	Crane Creek**; Darby Beach*; Darby West**; CedarPoint Lambswoods**; Northwoods**; VCW**
Crane Creek	Butternut*; Boss**; Darby Beach**; Darby West**; CedarPoint Lambswoods*; Northwoods**; Price**; Cedarpoint Pointwoods*; VCW**
Darby Beach	Butternut*; Boss*; Crane Creek**; Darby West*; Northwoods**; Price**; VCW**
Darby West	Butternut**; Boss**; Crane Creek**; Darby Beach*; CedarPoint Lambswood**; Northwoods**; Price**; CedarPoint Pointwoods**; VCW**
CedarPoint Lambswood	Butternut*; Boss**; Crane Creek*; Darby West**; Northwoods*; Price**; VCW**
Northwoods	Boss**; Crane Creek**; Darby Beach**; Darby West**; CedarPoint Lambswood*; Price**; CedarPoint Pointwoods*;
Price	Crane Creek**; Darby Beach**; Darby West**; CedarPoint Lambswood**; Northwoods**VCW**
CedarPoint Pointwoods	Crane Creek*; Darby West**; Northwoods*; VCW**
VCW	Butternut*; Boss**; Crane Creek**; Darby Beach**; Darby West**; CedarPoint Lambswood**; Price**; CedarPoint Pointwoods

* = $P < 0.05$; ** $P < 0.01$

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Indicator Analyses. In order to predict if there are significant overstory indicator species for each stand at Ottawa NWR, we used Indicator Species Analysis following the procedure outlined in Dufrene and Legendre (1997). We use PC-ORD (ver. 5.0) to conduct the Indicator Species Analysis using the relative basal area (%) of all species and all plots except Crane Creek Plot 2 which had not overstory component.

Based upon the Indicator Species Analysis, we found the following species were significant indicators ($P < 0.05$) of the following stands:

Stand	Indicator Species
Butternut	none
Boss	none
Crane Creek	green ash
Darby Beach	boxelder; mulberry
Darby West	white ash
CedarPoint Lambswood	hackberry
Northwoods	none
Price	none
CedarPoint Pointwoods	none
VCW	northern red oak

Gradient Analysis. Using relative basal area by species (%) of the 53 plots sampled (Crane Creek Plot 2 not included as no overstory species recorded) across the different stands at Ottawa NWR as part of the Rapid Ecological Assessment (Corace et al. 2011), we examined the distribution of overstory species across sampled stands using Non-Metric Dimensional Scaling (NMDS). NMDS is a non-parametric ordination analysis that maximizes the rank-order correlation between distances. Unlike other indirect (e.g., principal components analysis) or direct (e.g., canonical correspondence analysis) ordination techniques, NMDS does not make any assumptions about the nature of the data, including assumptions about the linear relationship among variables. As a result, it is often viewed as an appropriate multivariate analysis for ecological data (McCune and Grace 2002).

Prior to the analysis, the relative basal area data by species were transformed using an arcsin squareroot transformation as is appropriate with percentage data. NMDS was then run using PC-ORD (ver. 5.0) software using a Sorenson distance measure. A three-dimensional solution was determined to be the most appropriate (Monte Carlo test, $n = 200$ runs).

Although the MRPP suggest there are differences in the overstory composition of forested stands at Ottawa NWR, there appears to be considerable plot-to-plot variability in overstory relative basal area as indicated by the overlap of plots representing the different stands in the NMDS ordination (Figure 1). While certain stands have similar overstory composition and appear to be different in terms of the overstory composition relative to the other stands (e.g., Darby West), others are more variable (e.g., Northwoods, Boss).

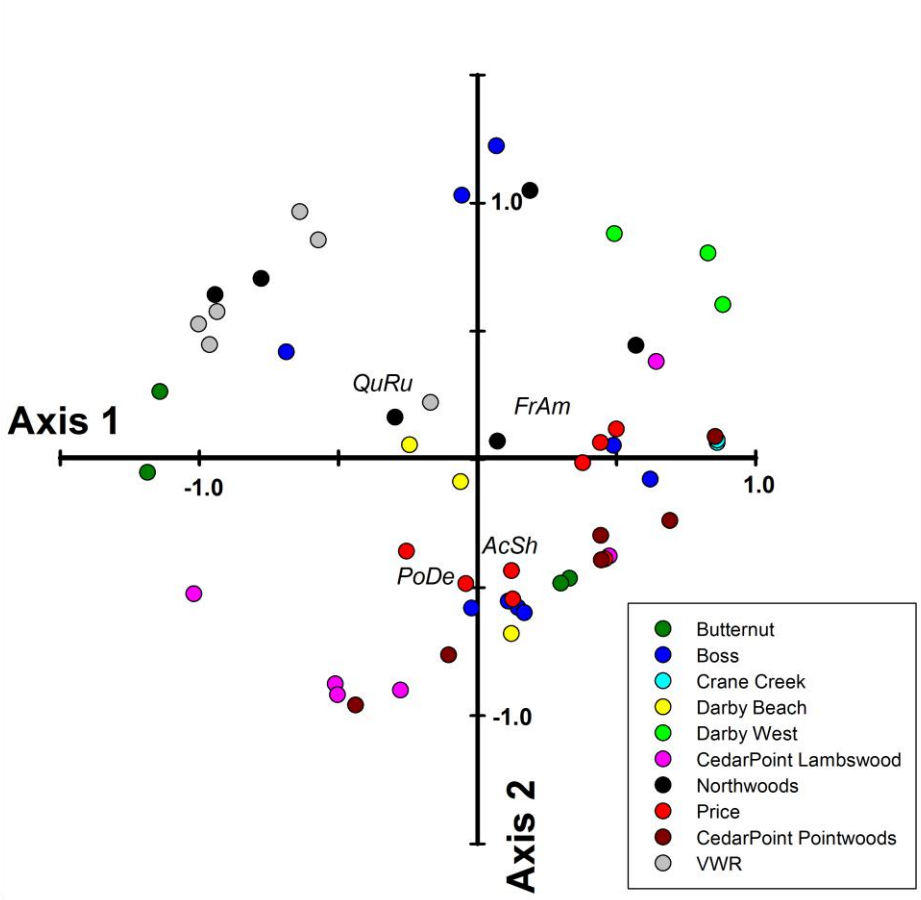

Fig. 1. NMDS ordination of overstory species based upon relative basal area for 10 stands at Ottawa National Wildlife Refuge. Species acronyms correspond to first two letter of genus and species (e.g., QuRu = *Quercus rubra*). Only those species with a cutoff value of 0.20 included in ordination diagram.

Based upon the NMDS, it is difficult to make specific predictions about the factors that may be driving differences in overstory composition at Ottawa NWR. It is possible there is a soil moisture gradient underlying the patterns observed in the NMDS, as the plots characterized by northern red oak (QuRu) are distributed in the upper left-hand portion of the ordination, while plots dominated by more wet-mesic species including silver maple (AcSh) and cottonwood (PoDe) characterize the plots in the lower right-hand portion of the ordination diagram (Figure 1). Across this overall soil moisture gradient, differences in species compositions may also be related to past disturbances. However, more information (e.g., soils, past history) on these different stands and plots is needed to make a more conclusive statement regarding the factors driving patterns in overstory composition.

Analysis Implications. These basic results confirm the summary information developed by Corace et al. (2011). Specifically, there are unique forest communities at Ottawa NWR that are dominated by a mixture of species that most likely reflect dominant environmental and disturbance gradients of the region. The analyses also strongly indicate that there is considerable variability at local scales within

each stand. These results suggest that individual stands may include different overstory communities in response to varying environmental or disturbance related factors within each stand. This variability may suggest that managing individual stands as *homogenous landscape units* is not appropriate and individual stands may require different management recommendations and guidelines depending on management objectives. For example, based upon these data, the plots that represent the Boss stand suggest two distinct overstory communities – one dominated by more mesic upland species (including northern red oak and white ash) and another dominated by more wet-mesic species (silver maple and cottonwood). Management activities, including forest ecosystem restoration practices, would need to be tailored for each specific condition.

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References:

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